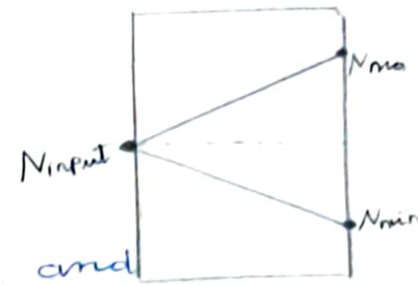
BASIC RULES FOR OPTIMUM GEAR BOX DESIGN:-

The basic rules to be followed while designing the gear boxes are as follows:-



1) The Transmission ratio (i)

$$\frac{1}{4} \leq i \leq 2$$

$$i_{min} = \frac{N_{min}}{N_{input}} \geq \frac{1}{4} \text{ and}$$

$$i_{max} = \frac{N_{max}}{N_{input}} \leq 2$$

2) For stable operation, the speed ratio at any stage should not be greater than 8.

$$\frac{N_{max}}{N_{min}} \leq 8.$$

3) In all stages except in the first stage,

$$N_{max} \geq N_{input} > N_{min}$$

4) The sum of teeth of mating gears in a given stage must be the same for same module in a sliding gear set.

5) The minimum no. of teeth on smallest gear in drives should be greater than (or) equal to 17.

6) The minimum difference between the number of teeth of adjacent gears must be 4.

7) Gear box should be of minimum possible size. Both radial as well as axial dimensions should be as small as possible.

Sketch the speed diagram and the kinematic layout for an 18 speed gear box for the following data.

Motor speed = 1440 rpm, Minimum output speed = 16 rpm, Maximum output speed = 800 rpm, Arrangement = 2×3×3.

List the speeds of all the shafts when the output speed is 16 rpm.

Given Data:-

$n = 18$; $N_{input} = 1440$ rpm, $N_{min} = 16$ rpm, $N_{max} = 800$ rpm ; 2×3×3.

To find:-

construction of the speed diagram and the kinematic layout.

Solution:-

Selection of spindle speeds:-

$$\frac{N_{max}}{N_{min}} = \phi^{n-1}$$

$$\frac{800}{16} = \phi^{18-1} \quad (\text{or}) \quad \phi = 1.258$$

We can write, $1.12 \times 1.12 = 1.254$.

So, $\phi = 1.12$ satisfies the requirement. Therefore the spindle speeds from R20 series, skipping one speed, are given by,

16, 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630 and 800 rpm.

Structural formula:-

Given that, 2×3×3 (ie, $P_1 \cdot P_2 \cdot P_3$).

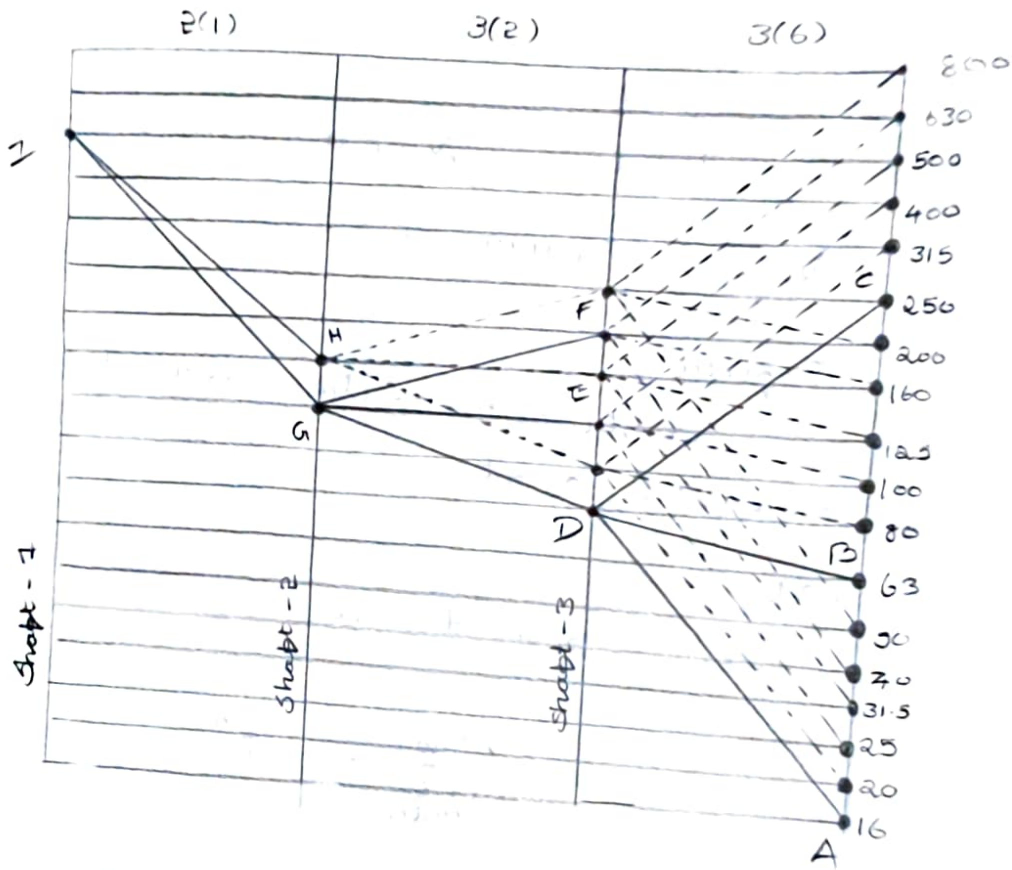
Structural formula = $P_1(X_1)\ P_2(X_2)\ P_3(X_3)$

$x_1 = 1,\ x_2 = P_1 = 2,\ x_3 = P_1 \cdot P_2 = 2 \times 3 = 6$ ⓧ

structural formula : 2(1) 3(2) 3(6)

Speed diagram:

The speed diagram is drawn, as shown in fig. using the procedure discussed in example.



$$\frac{N_{min}}{N_{input}} = \frac{16}{80} = 0.2 > \frac{1}{4} \text{ and}$$

$$\frac{N_{max}}{N_{input}} = \frac{250}{80} = 3.125 > 2.$$

In this stage, ratio requirements are not satisfied so it can be treated as an exceptional case.

$$\frac{N_{min}}{N_{input}} = \frac{80}{125} = 0.64 > \frac{1}{4} \text{ and}$$

$$\frac{N_{max}}{N_{input}} = \frac{250}{125} = 2.$$

Should be ..

(4) Stage 1:

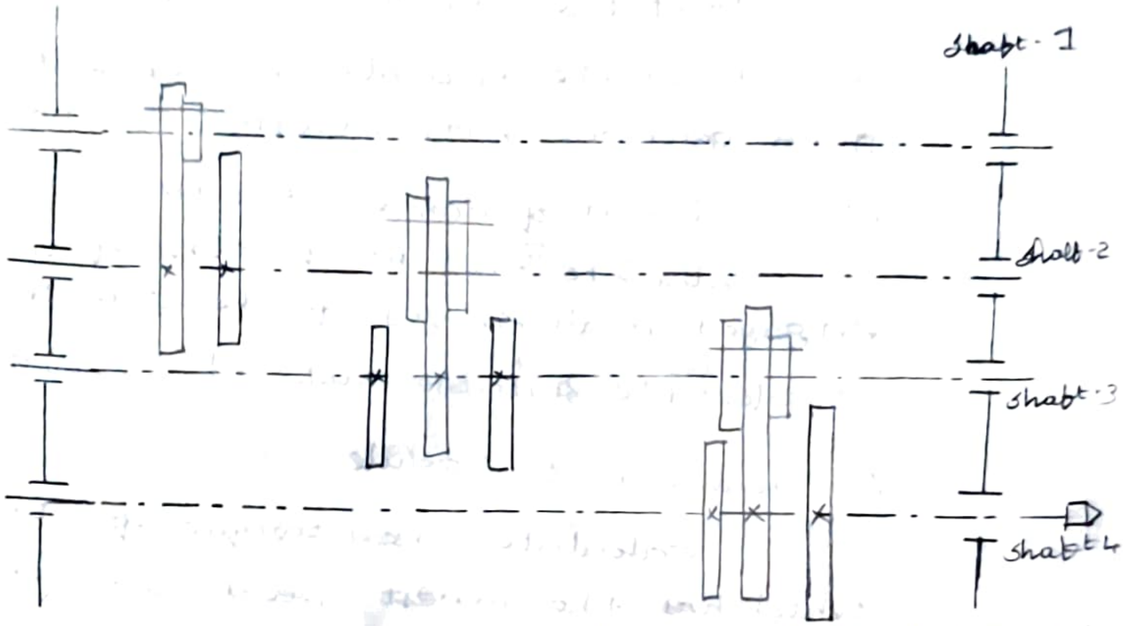
$$\frac{N_{min}}{N_{input}} = \frac{125}{500} = 0.25 \leq 1/4$$

$$\frac{N_{max}}{N_{input}} = \frac{160}{500} = 0.32 < 2$$

Ratio requirements are satisfied in stages 2 and 1

Kinematic layout:

The kinematic layout for the 18 speed gear box is drawn, as shown in fig.



Speeds of all the shafts when the output speed is 16 rpm:

From the speed diagram, speeds of all the shafts when the output speed is 16 rpm, are given by:

Speed of shaft 3 = 80 rpm

Speed of shaft 2 = 125 rpm

Speed of shaft 1 = 500 rpm.